IMPROVEMENTS IN RECIPROCATING MACHINES

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to reciprocating machines such as vacuum pumps which incorporate a reciprocating piston and control systems therefore.

Vacuum pumps incorporating a reciprocating piston mode of operation are known which have an electromagnetic actuator arrangement driving a piston for the pump.

In European patent publication no. 0793019 there is described a vacuum pump which uses a multi-stage reciprocating piston mode of operation in which piston reciprocation is effected by an electromagnetic drive means and a counter-acting spring means and in which the pump stages are connected in series between a pump inlet and a pump outlet such that, in use, gas being transferred through the pump passes through the stages in turn.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide a machine and more particularly, a vacuum pump incorporating a reciprocating piston for which a vibration sensor is used to control the piston stroke and thus avoid over driving the piston for the machine/vacuum pump.

It is another object of the present invention to provide a control system for use with a piston in for example a vacuum pump to control the stroke of the piston within a cylinder of the pump.

It is another object of the present invention to provide a closed loop central system for a machine such as a vacuum pump.

According to the present invention, a machine consists of a cylinder closed at both ends, one of the ends adapted to receive a piston, the piston mounted for reciprocable movement within the cylinder between each end, means for driving the piston, and a vibration sensor for sensing any contact between the piston and the ends of the cylinder.

In a preferred embodiment of the present invention, the machine is a vacuum pump, the vibration sensor is a piezoelectric device and the driving means includes an electro-magnet.

Preferably, the machine is driven by a closed loop control system including the vibration sensor, a variable drive and an electronic circuit which is used to analyze a vibration sensor output signal to determine the drive voltage for the piston.

BRIEF DESCRIPTION OF THE DRAWING

An embodiment of the invention will now be described by way of example, reference being made to the Figure of the accompanying diagrammatic drawing which is a schematic illustrating the relationship between the drive means, reciprocating piston, vibration sensor and controller of a machine according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in the Figure, a vibration sensor 3, for example a piezoelectric device, is mounted on a machine in the form of a pump 1, such that any end collision of reciprocation piston 5 is detected, for example on the end of the pump 1. Vibration sensor 3 is electrically/electronically connected to a controller 2 in the form of an electronic circuit, for example a micro-processor. The controller 2 is electrically/electronically linked to a variable voltage drive 4 including an electromagnet which is itself mechanically linked to the piston 5 of the pump 1, to form a closed loop control system. The controller 2 interconnects the vibrator sensor 3 and the driver 4. The vibration sensor 3 can be mounted to an end of the pump 1 opposite to that which the sensor 3 is shown mounted in the Figure.

In use, the controller 2 is set to deliver a gradually increasing voltage across the driver 4. This has the effect of gradually increasing the stroke length of the piston 5. Should the end of the piston 5 strike an end plate at either end of the pump 1, this is detected by the vibration sensor 3 which generates a signal which is transmitted to the controller 2. Receipt of the signal from the vibration sensor 3 then causes the controller 2 to reduce the drive voltage to the driver 4.

In the above described embodiment, the pump 1 is driven by a closed loop control system which includes a vibration sensor 3, a variable driver 4 and a controller 2 which is used to analyze the sensor output from the vibration sensor 3 to determine the drive voltage.

The vibration sensor 3 is effectively used to maximize the piston stroke by sensing any end point engagement of the piston 5 on the pump 1 and thereby avoid over driving the pump. The vibration sensor 3 is able to detect collision at either end of the pump 1, therefore the maximum stroke is achieved independent of any offsets in the system.

Although reference is made in the above-described embodiment to a variable voltage drive means, the drive means could be a variable current drive.

The benefits of the control means are:

- optimum performance of the machine is achieved through maximised stroke length.

- the closed loop control provides inherent compensation for mechanical load and power supply variations.

- the vibration sensor 3 is not intrusive to the pump 1 and preferably mounted to an exterior of the pump as shown in the Figure and therefore, not vulnerable to contamination or corrosive action.

- the vibration sensor 3 does not require accurate calibration or positioning, indeed the sensor may be mounted on any appropriate surface of the machine.

- the electronic controller may detect vibration sensor failure or detachment by monitoring the background vibration level from the sensor 3.

- the closed loop control provides inherent compensation for change in mechanical performance over time.

- the closed loop control requires minimal set up in manufacture and service.

It will be understood that the embodiments described herein are exemplary of the present invention and that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention. All such modifications and variations are intended to be included within the scope of the invention as defined in the appended claims.